PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 13985/WO/01	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/IL 02/00975	International filing date *(day/month/year)* 04.12.2002	Priority date *(day/month/year)* 17.01.2002
International Patent Classification (IPC) or both national classification and IPC H01L21/66		
Applicant INNERSENSE LTD. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 10 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
08.06.2003	29.04.2004
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Kusztelan, L Telephone No. +49 89 2399-2479

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IL 02/00975

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

1-32 as published

Claims, Numbers

1-27 received on 14.04.2004 with letter of 14.04.2004

Drawings, Sheets

1/3-3/3 as published

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐ the language of publication of the international application (under Rule 48.3(b)).

   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority in written form.

   ☐ furnished subsequently to this Authority in computer readable form.

   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☐ the claims, Nos.:

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-27
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-27
Industrial applicability (IA)	Yes:	Claims	1-27
	No:	Claims	

2. Citations and explanations

   see separate sheet

Section V

1. The present application does not satisfy the criterion set forth in Art. 33(3) PCT because the subject-matter of claims 1 & 23 does not involve an inventive step in respect of prior art as defined in the regulations (Rule 64(1)-(3)).

1.1 D1, cf. Figs.1 & 2 & corresponding text discloses a system for recording the motion of a wafer, including a reader station & a computer (col.4 lines 5-25) for recording wafer motion as it proceeds through processing apparatus e.g. a contact printer, cf. col.2 lines 14 to col.3 line 50 which through the contact nature will involve rapid deceleration & thus creation of particles. The computer system thus implicitly comprises initialisation, download, transfer software as well as known data for comparison purposes, cf. col.4 lines 25-35.

The known wafer also has an accelerometer, cf. col.7 lines 62-68 & col.9 lines 28-30, thus is capable of characterising wafer motion. Moreover it is implicit that the known system includes inspection machines (e.g. the contact printing necessarily involving inspection of the wafer during printing) and it is apparent that the system comprises a test wafer, cf. col.13 lines 3-5. It is also implicit that the known system is used to monitor each process step, cf. col.1 lines 40-51.

The claimed system differs therefrom in that the motion of the test wafer is to be recorded along the entire path through & between process & inspection machines.

It appears immediately obvious to the skilled person, knowing of the automated robotic nature of modern semiconductor processing clean rooms that the recorded data of the D1 device, including that from the vibration & acceleration or movement of the wafer through the chamber and inbetween chambers will be used to control accurate placement of the wafer, cf. col.2 lines 21-28, thereby allowing identification of mechanical malfunctions of processing equipment, Art.33(3) PCT.

1.2 The objection under Art.33(3) PCT against claim 23 is based on the citations & arguments given in Section 1.1.

2. Concerning the subject-matter of the dependent claims, their additional matter is either known directly from D1 or in the aspects of test wafer design cf. claims 4-9 appear to consist in obvious adaptations. Accordingly an inventive nature of the subject-matter of the application is not percieved.

Claims

1. A system for detecting, identifying, and locating any mechanical malfunction, which has caused, or could cause, defects in a wafer manufactured by semiconductor process and inspection machines in the course of the actual manufacturing process or in test cycles of said machines, said system comprising:
   - a test wafer, comprising a miniature electronic recording system, which comprises at least one accelerometer and circuitry for recording data that characterizes the motion of said test wafer, including fine perturbations and vibrations in its motion during its progress through and between said semiconductor process and inspection machines;
   - a computer, comprising: software for initializing and downloading recorder programs to said miniature electronic recording system before said test wafer is placed in said semiconductor process and inspection machines; software for transferring said data that characterizes the motion of said test wafer from said miniature electronic recording system to said computer; known data, which describes the "known good" behavior of a wafer during its progress through and between said semiconductor process and inspection machines; and software for detecting, identifying, and

locating said mechanical malfunction; and

- a reader station, comprising an AC power supply, interface circuits between said test wafer and said computer, and, if necessary, a battery charger;

wherein;

- said recorder programs cause said data that characterizes the motion of said test wafer to be recorded along the entire path of said test wafer through and between said semiconductor process and inspection machines; and
- said software for detecting, identifying, and locating said mechanical malfunction detects, identifies, and locates said mechanical malfunction by comparing said recorded data that characterizes the motion of said test wafer with said known data.

2. A system according to claim 1, wherein the test wafer is selected from the group comprising:

- wafers whose surface area and, shape, thickness, and weight are essentially equal to those of standard size production wafers; and
- wafers whose surface area and shape are essentially equal to those of standard size production wafers but whose thickness and/or weight differ from those of standard size production wafers.

3. A system according to claim 2, wherein the test wafer is made from a material selected from the group comprising:
   - silicon;
   - aluminum;
   - glass;
   - gallium arsenide;
   - ceramic material; and
   - plastic.

4. A system according to claim 1, wherein the miniature electronic recording system is attached to the test wafer by means selected from the group comprised of:
   - gluing;
   - screwing; and
   - bolting;

5. A system according to claim 1, wherein the components of the miniature electronic recording system are mounted on one or more circuit boards.

6. A system according to claim 1, wherein the miniature electronic recording system is covered by an epoxy block molded on the

wafer.

7. A system according to claim 1, wherein a thin hermetic external cover is mounted over the miniature electronic recording system and is attached to the wafer.

8. A system according to claim 7, wherein the hermetic thin casing has a thickness such that the maximum height of the electronics and cover is preferably no more than 2mm.

9. A system according to claim 7, wherein the hermetic thin casing is made of a material chosen from the group comprised of:

- aluminum;
- stainless steel;
- composite materials;
- polyurethane;
- silicon;
- ceramic materials; and
- plastic.

10. A system according to claim 1, wherein the miniature electronic recording system additionally comprises components selected from the group comprised of:

- analog-to-digital converters;
- microprocessors;
- batteries;
- memory units;
- temperature sensors;
- analog multiplexers;
- analog filters;
- peak-detectors; and
- sample-and-hold electronic circuits.

11. A system according to claim 1, wherein the accelerometers are selected from the group comprised of:
    - dual-axis accelerometers;
    - 3-axis accelerometers; and
    - piezoelectric accelerometers.

12. A system according to claim 10, wherein the analog-to-digital converter includes an analog multiplexer, which enables the digitizing of a multitude of analog signals.

13. A system according to claim 10, wherein the microprocessor includes a real-time clock and internal program memory.

14. A system according to claim 10, wherein the battery is a rechargeable battery.

15. A system according to claim 14, wherein the rechargeable battery is a lithium polymer battery.

16. A system according to claim 10, wherein the memory unit is composed of RAM memory and/or Flash memory.

17. A system according to claim 1, wherein additional sensors are attached to the test wafer, said sensors being suitable to measure parameters selected from the group comprised of:

- temperature;
- light;
- pressure;
- air-flow;
- gas flow;
- humidity;
- clearance;
- electric field; and
- magnetic field.

18. A system according to claim 1, wherein a miniature camera is

attached to the test wafer.

19. A system according to claim 1, wherein the miniature electronic recording system detects the motion of the test wafer to which it is attached and uses the presence or absence of said motion to switch off or wake up said electronics in order to conserve power.

20. A system according to claim 1, wherein the interface circuits of the reader station are electronic interface circuits.

21. A system according to claim 1, wherein the interface circuits of the reader station are non-contact interface circuits.

22. A system according to claim 21, wherein the non-contact interface circuits of the reader station are optical interface circuits or radio frequency interface circuits.

23. A method for using a record of the motion of a test wafer, including fine perturbations and vibrations in the motion of said wafer, during its progress through and between semiconductor process and inspection machines in the course of the actual manufacturing process or in test cycles of said machines, to detect, identify, and locate any mechanical malfunction of the

processing machine which has caused, or could cause, defects in the manufactured wafer, comprising the following steps:

- placing said test wafer on the reader station;
- initializing said test wafer;
- transferring said test wafer to said processing machine;
- operating said processing machine under normal operating conditions;
- recording, in the miniature electronic recording system mounted on said test wafer, data from at least one accelerometer, said data characterizing the motion of said test wafer;
- processing the signals from the accelerometer on said test wafer;
- returning said test wafer to said reader station;
- downloading said recorded data into a computer;
- erasing, if desired, said data recorded in said of said miniature electronic recording system; and
- detecting, identifying, and locating any mechanical malfunction of the processing machine;

wherein;

- said data that characterizes the motion of said test wafer is recorded along the entire path of said test wafer through and between said semiconductor process and inspection machines;

and

- the software of said computer detects, identifies, and locates said mechanical malfunction by comparing said recorded data characterizing the motion of said test wafer with known data previously stored in the memory of said computer.

24. A method according to claim 23, wherein initializing the test wafer includes some or all of the following steps:

- recharging a battery on said test wafer;
- downloading different versions of recording programs and/or other parameters from the computer into the memory of said test wafer; and
- initializing the real-time clock on said test wafer.

25. A method according to claim 23, wherein the signals are processed using one of the strategies selected from the group comprising:

- on-wafer signal processing followed by low sampling-rate signal digitizing; and
- high-rate signal sampling followed by computer-based signal processing.

26. A method according to claim 23, wherein the known data to

which the recorded data is compared is selected from the group comprising:

- the precise known time-schedule of events inside the processing machine; and
- "known-good" readings or "fingerprints" of signals previously recorded on the same or on similar processing machine.

27. A method according to claim 23, wherein comparing the recorded data to known data additionally comprises the use of special software for signal recognition to automatically detect and interpret "known" problems.